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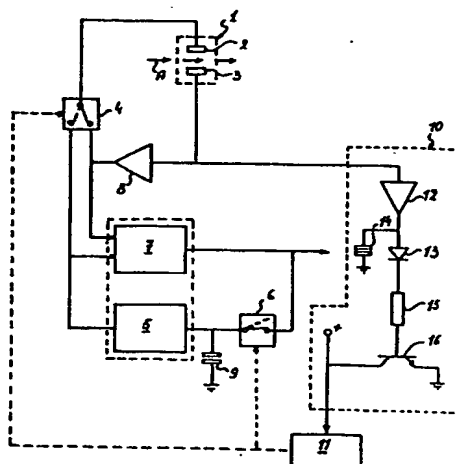
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54 Device for the detection of sheet-like objects.

57 Ultrasonic double-sheet detecting system in which the frequency of the ultrasonic source (2) is tuned to the natural frequency of the total system in the circumstances as things are. When no sheet-like object is present in the detecting system this system is in a situation comparable with proximities between microphone and loud speaker, and the frequency of the oscillator (5) is tuned thereto. When a sheet-like object is present that situation is replaced by a comparative situation between the phases of the oscillator (5) and of the ultrasonic signal receiver (3).



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DEVICE FOR THE DETECTION OF SHEET-LIKE OBJECTS.

The invention relates to a device for the detection of the presence of more than one sheet-like object moving along a transport path, comprising an ultrasonic signal source and an ultrasonic signal receiver which are arranged on either side of the transport path, in which the  
5 source transmits a signal to the receiver through the transport path, an oscillator and a phase comparator, the inputs of which comparator are connected to the outputs of the oscillator and the receiver.

Such a device is known from British Patent Specification  
1 533 630. With this known device the oscillator is set to a certain  
10 frequency. Variations in the characteristics of the source and the receiver and variations in temperature and/or humidity, as a result of which the properties of the air between the source and receiver change, cause a varying phase difference between oscillator and receiver when no sheet-like object is present. Furthermore any change in the  
15 distance between the source and the receiver will bring about a different phase difference. The result of all this is that the device cannot be operated reliably under all circumstances.

The aim of the invention is to provide a device of the type mentioned in the preamble which avoids the disadvantages mentioned.

20 This aim is achieved in accordance with the present invention in that the output of the phase comparator can be connected with a control input of the oscillator via a switching element, in that the source is connected with a changeover switching element which in a first position connects the source with the output of the oscillator, and  
25 in a second position connects the source with the output of the

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receiver, and by virtue of the fact that a control circuit is provided which -in the absence of a sheet-like object for some period- closes the switching element and maintains the changeover switching element in the second position.

5 This design ensures that when no sheet-like object is present the ultrasonic source and the receiver are included in a "free oscillator" (comparable with proximities between microphone and loud speaker). As a result a certain natural frequency is set up, the phase displacement between source and receiver being dependent solely on the elements in  
10 the feedback chain. At the same time the oscillator is tuned to this natural frequency. Furthermore this ensures that the distance between the source and receiver is no longer critical and a wider margin can be tolerated.

Preferably the control circuit contains a detector connected with  
15 the receiver and which reacts to amplitude changes. This ensures that the changeover switch remains in the second position only when no sheet-like object is present.

Other characteristics and advantages of the invention will be explained in the following description, where reference is made  
20 to the attached drawing which provides a schematic electrical circuit diagram for realisation of the invention.

In the diagram a device is illustrated for the detection of several sheets, such as for example can be employed in a copying machine. Here the sheets move along a transport path, schematically  
25 indicated by the arrows A. A sheet detector 1 is located by this transport path and comprises a signal source 2 for the generation of ultrasonic vibrations and a receiver 3 for these vibrations, the source 2 and the receiver 3 being arranged opposite each other on either side of the transport path. The input of the source 2 is connected  
30 via a changeover switch 4 with the output of an oscillator 5, in the embodiment shown this being a voltage-controlled oscillator (V.C.O.). The control input for the oscillator 5 is connected via a switching element 6 with the output of a phase comparator 7. The control input of the oscillator 5 is at the same time connected via a capacitor 9  
35 to earth. In the embodiment illustrated the integrated circuit type 4046 has been employed for the oscillator 5 and the phase comparator 7.

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The first input of the phase comparator 7 is connected with the output of oscillator 5. Via an amplifier 8 the second input of the phase comparator 7 is connected with the receiver output. By means of changeover element 4 it is possible, as required, for source 2 to be connected with the oscillator 5 or with receiver 3. In the first case the source then transmits signals at the frequency of oscillator 5.

In the output of phase comparator 7 a direct voltage signal is now generated which is proportional to the phase displacement between the input signals. The direct voltage signal can furthermore be compared with a reference voltage from which it is possible to then derive the presence of a single sheet or a double sheet between the source and the receiver. In the second case a feed back circuit forms which starts to oscillate at a preferred frequency. This frequency depends on a number of factors such as the temperature of the air, characteristics of the electrical components in the chain, the distance between source and receiver, etc. The oscillator is now regulated to exactly the same frequency via switch 6 and phase comparator 7.

When changeover switching takes place from the second to the first position, there is always a defined phase difference of  $0^0$  between the signal offered to the source and the signal from the receiver, regardless of the tolerances in components and the distance between source and receiver. As a result the device can operate reliably under all circumstances and adjustments are superfluous.

The receiver 3 is also connected with an amplitude detection circuit which reacts to a sudden increase in the amplitude of the signal received by the receiver 3. The amplitude detection circuit 10 contains an operational amplifier, the output of which is connected with the base of a transistor 16 via a rectifier circuit consisting of a diode 13 and a capacitor 14 and a resistor 15. The emitter of transistor 16 is connected to earth and the collector is connected with a positive terminal of a voltage supply source. As soon as the amplitude of the receiver 3 signal exceeds a certain value the transistor 16 will conduct, so that the potential in the collector will reduce. On each occasion when a change occurs in the detector from a condition in which a sheet-like object is present to a condition in which no sheet-like object is present a potential drop occurs in the collector. The collector of transistor 16 forms the output of circuit 10. This output is connected with the input of a monostable multivibrator 11, the

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output of which is connected with the changeover switching element 4 and switching element 6. By this means it is ensured that when, via circuit 10, no sheet-like object is detected between source 2 and receiver 3, a signal is generated by the mono-stable multivibrator 11 5 by means of which changeover switching element 4 connects the source 2 with receiver 3 and the switching element 6 is closed. This signal from the multivibrator 11 is generated for only a short period, after which the adjustment of oscillator 5 is performed by the capacitor 9 and the switch 6.

10 It is obvious that the invention is not restricted to the embodiment described and illustrated here, but that numerous modifications can be incorporated within the framework of the following claims, particularly as regards the electrical components employed.

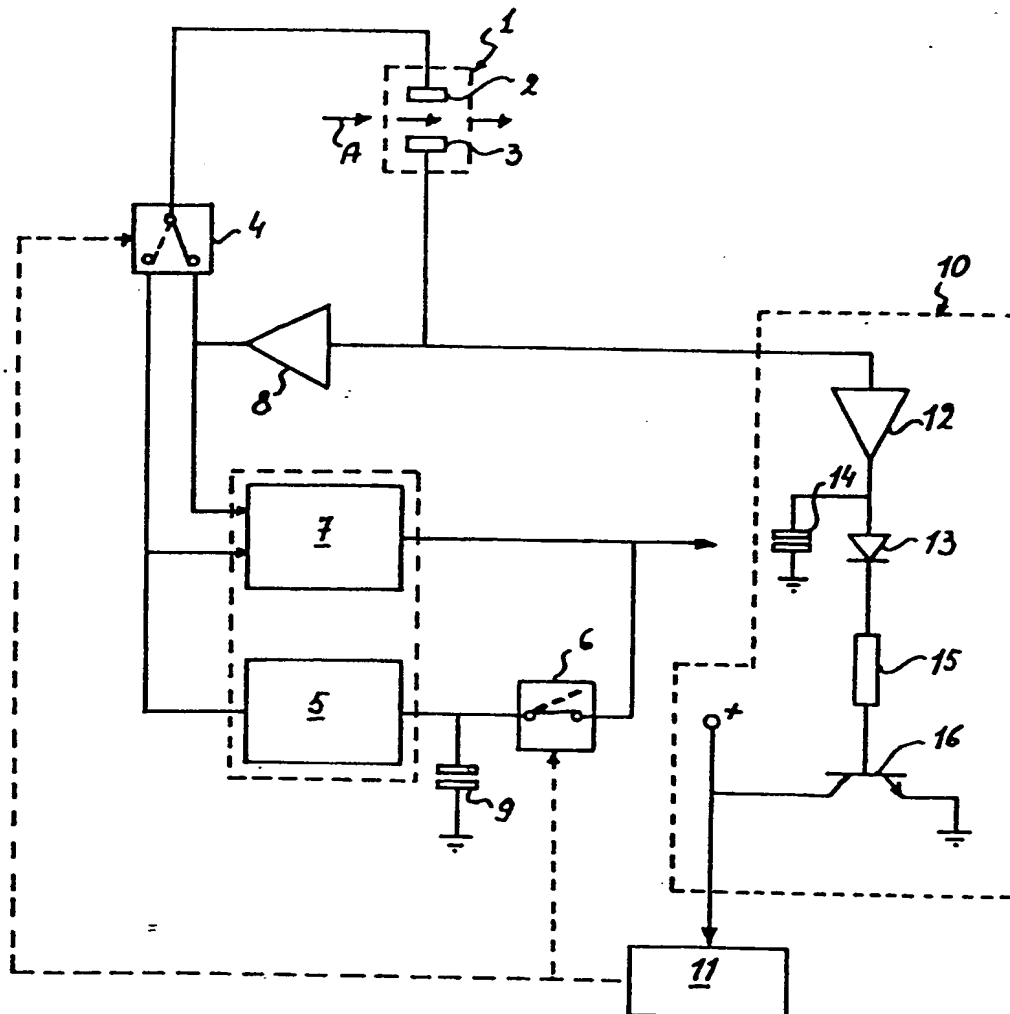
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Claims.

1. Device for the detection of the presence of more than one sheet-like object moving along a transport path, comprising an ultrasonic signal source (2) and an ultrasonic signal receiver (3) which are arranged on either side of the transport path (A), in which the source  
5 (2) transmits a signal to the receiver (3) through the transport path (A), an oscillator (5) and a phase comparator (7), the inputs of which comparator (7) are connected with the outputs of the oscillator (5) and the receiver (3), characterised in that the output of the phase  
10 comparator (7) can be connected with a control input of the oscillator (5) via a switching element (6), that the source (2) is connected with a changeover switching element (4) which in a first position connects the source (2) with the output of the oscillator (5) and in a second position connects the source (2) with the output of the receiver (3), and that a control circuit (11) is provided which in the absence of a  
15 sheet-like object for some period closes the switching element (6) and maintains the changeover switching element (4) in the second position.
2. Device in accordance with claim 1, characterised in that the control circuit (11) contains a detector (10) which is connected with  
20 the receiver (3) and which reacts to changes in amplitude.

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European Patent  
Office

# EUROPEAN SEARCH REPORT

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Application number

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DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	<u>DE - A - 2 063 540</u> (XEROX) * The complete description *	1	B 65 H 7/12 G 01 B 17/02
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A	<u>US - A - 3 967 143</u> (OKI ELECTRIC) * The complete description *	1	
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			TECHNICAL FIELDS SEARCHED (Int. Cl.)
			B 65 H G 01 B G 01 D
			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
<input checked="" type="checkbox"/> The present search report has been drawn up for all claims			&: member of the same patent family, corresponding document
Place of search The Hague		Date of completion of the search 08-05-1981	Examiner LONCKE

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